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FLOOD POTENTIAL OF TOPOPAH WASH AND TRIBUTARIES, EASTERN PART OF JACKASS FLATS, NEVADA TEST SITE, SOUTHERN NEVADA

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CONVERSION FACTORS

The following factors may be used to convert inch-pound units to metric units.

Multiply inch-pound units	*By*	*To obtain metric units*
inch	25.40	millimeter
foot	0.3048	meter
mile	1.609	kilometer
square foot	0.0929	square meter
square mile (mi^2)	2.590	square kilometer
foot per second	0.3048	meter per second
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer
degree Fahrenheit (°F)	5/9(°F-32°)	degree Celsius (°C)

FLOOD POTENTIAL OF TOPOPAH WASH AND TRIBUTARIES, EASTERN PART OF JACKASS FLATS, NEVADA TEST SITE, SOUTHERN NEVADA

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ABSTRACT

Guidelines for evaluating potential surface facilities to be used for the storage of high-level radioactive wastes on the Nevada Test Site in southern Nevada include the consideration of the potential for flooding. Those floods that are considered to constitute the principal flood hazards for these facilities are the 100- and 500-year floods, and the maximum potential flood. Flood-prone areas for the three floods with present natural-channel conditions were defined for the eastern part of Jackass Flats in the southwestern part of the Nevada Test Site in cooperation with the U.S. Department of Energy.

The 100-year flood-prone areas would closely parallel most stream channels with very few occurrences of out-of-bank flooding between adjacent channels. Out-of-bank flooding would occur at depths of less than 2 feet with mean velocities as much as 7 feet per second. Channel flood depths would range from 1 to 9 feet and mean velocities would range from 3 to 9 feet per second.

The 500-year flood would exceed the discharge capacities of all channels except for Topopah Wash and some channels in the upstream reaches of a few tributaries. Out-of-bank flows between adjacent channels would occur at depths as much as 3 feet with mean velocities of more than 7 feet per second. Channel flood depths would range from 1 to 12 feet and mean velocities would range from 3 to 13 feet per second.

The maximum potential flood would inundate most of the study area. Excluded areas would be those located immediately east of the upstream reach of Topopah Wash and between upstream channel reaches of some tributaries. Out-of-bank flows between adjacent channels would occur at depths as much as 5 feet with mean velocities as much as 13 feet per second. Channel flood depth would range from 2 to 23 feet and mean velocities would range from 4 to 26 feet per second.

Severe erosion of channels and flood plains would occur in parts of the study area during the 100-year flood, and would be more widespread during the 500-year flood and the maximum potential flood.

INTRODUCTION

Environmental studies of the Nevada Test Site and vicinity (fig. 1) are being conducted by the U.S. Geological Survey in cooperation with the U.S. Department of Energy to define and describe those parts of the area that are both suitable and available for construction of surface-storage facilities for high-level radioactive wastes. Rogers, Perkins, and McKeown (1977) made a preliminary assessment of the seismic hazards of the Nevada Test Site region. Hoover, Eckel, and Ohl (1978) evaluated the topographic, geomorphic, and geologic features of the southwestern part of the Nevada Test Site and identified potential waste-storage sites for further study.

A more detailed study is being made now of the geology and hydrology of Jackass Flats, which is located in the southwestern part of the Nevada Test Site. This report describes that part of the hydrology that pertains to the evaluation of potential flooding in the eastern part of Jackass Flats. Data pertaining to 100- and 500-year floods and for the maximum potential flood were determined for Topopah Wash and tributaries upstream from Little Skull Mountain (pl. 1).

Description of Topopah Wash and Tributaries

Topopah Wash is the only major drainage channel in the eastern part of Jackass Flats (pl. 1). The headwaters of Topopah Wash originate along the southern part of Shoshone Mountain (fig. 1), which has an altitude of about 7,140 feet. The ephemeral stream drains south to Jackass Flats, then southwest by south through the middle of the flats, and then south and parallel to Fortymile Wash to the confluence with the Amargosa River at an approximate altitude of 2,100 feet (fig. 1).

The tributary channels east of Topopah Wash drain the southeastern part of Shoshone Mountain, the mountain slopes southwest of Lookout Peak, and the north-facing slopes of Skull and Little Skull Mountains (fig. 1). These channels converge into two main tributaries before entering Topopah Wash.

For identifying and referencing tributary stream channels in the study area,

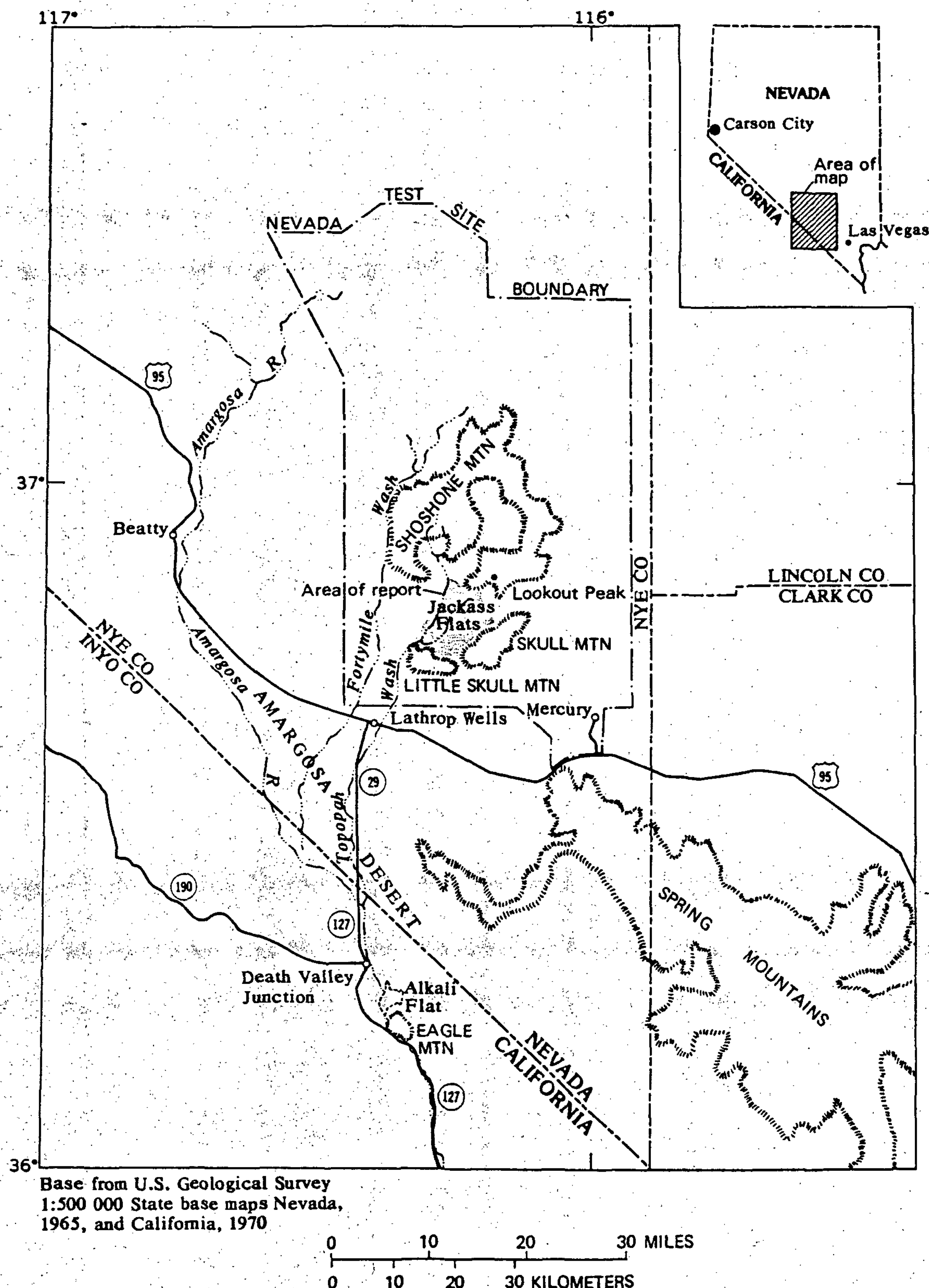


Figure 1.--Location of the Nevada Test Site and study area.

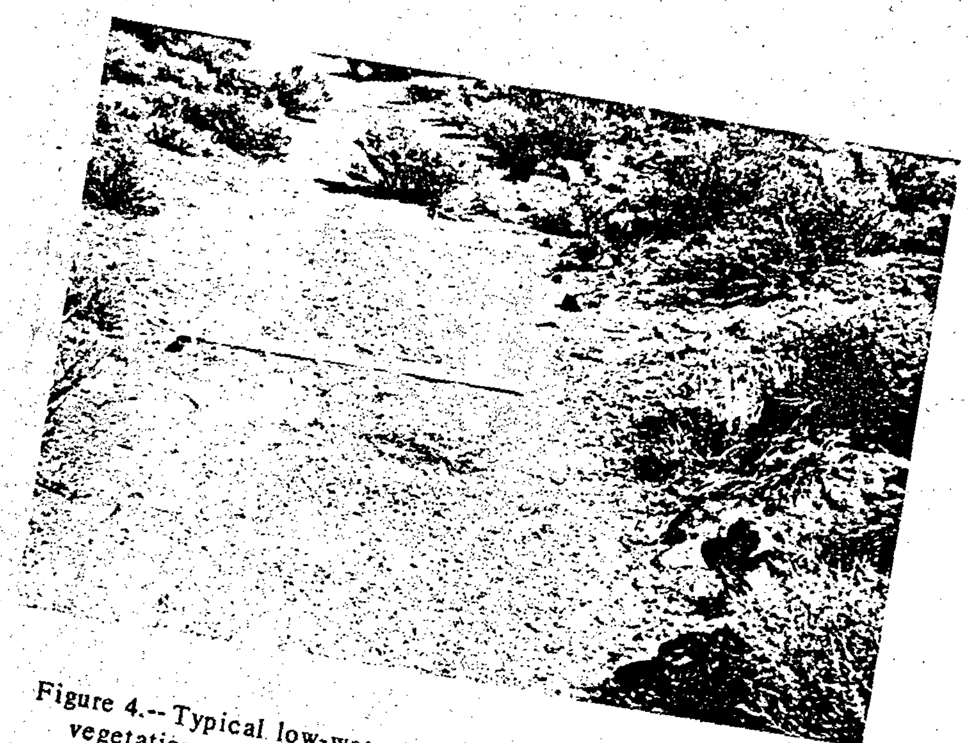


Figure 4.--Typical low-water channel, streambed material, and vegetation on banks. Photograph by William Thordarson.

The typical flood plain shown in figure 5 generally is covered with gravel to cobble-sized material embedded in soil and with scattered vegetation. The vegetative cover in the study area grows on about 30 to 50 percent of the flood plain and includes creosote bush, burro bush, and a variety of yuccas (Winograd and Thordarson, 1975).

Streambed and land slopes increase from 1 percent in the downstream reaches of the study area to 4 percent at an altitude of 4,000 feet.

Climate

Mean annual precipitation in the study area is about 4 inches (Nuclear Rocket Development Station, 1969) and on Shoshone Mountain, the highest point in the Topopah Wash basin, is less than 10 inches (Winograd and Thordarson, 1975, fig. 3). Mean monthly precipitation data for Jackass Flats indicate that about one-half of the annual precipitation occurs in the winter and most of the remainder occurs in the summer (Nuclear Rocket Development Station, 1969).

During the winter, storms associated with broad low-pressure systems that develop over the Pacific Ocean move eastward over the study area. Precipitation from these storms generally is widespread and only rarely is intense (Quiring, 1965). During the summer, local convective thunderstorms, associated with moisture from the Gulf of California and the southern Pacific Ocean, move northeastward over the study area. Precipitation from these storms generally is localized and can be intense (Hales, 1974; Hansen, 1975).

Temperature extremes in Jackass Flats range from about 7°F in January to 110°F in June and July. The average daily temperature is about 62°F (Nuclear Rocket Development Station, 1969).

HYDROLOGIC ANALYSES

Hydrologic analyses were made to determine methods of estimating the 100-year, 500-year, and maximum potential floods in the study area. Floods of these magnitudes would constitute the principal flood hazards to surface facilities used for storage of high-level radioactive wastes.

100- and 500-Year Floods

The discharge of a 100-year flood has a 1-percent chance of being equaled or exceeded during any year, while the discharge of a 500-year flood has a 0.2-percent chance of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average time between floods of a specific magnitude, floods with the same or greater magnitudes could occur at shorter intervals or even within the same year.

The magnitude and frequency of peak discharges at ungaged sites on streams

Table 1.--*Floodflow characteristics for the 100-year flood*

Flooding source and cross section: Stream-channel name and cross-section number shown on plate 1.
Discharge: 100-year discharge, in cubic feet per second.
Area: Cross-sectional area below the water surface, in square feet.
Width: Distance along the cross section and between the channel banks at the water surface, in feet.
Mean velocity: Discharge divided by area, in feet per second.
Maximum depth: Vertical distance from water surface to lowest point in cross section, in feet.

Flooding source and cross section	Discharge	Area	Width	Mean velocity	Maximum depth
Topopah Wash					
1------------	11,200	1,200	428	9	7
2------------	5,220	683	378	8	4
3------------	4,500	799	589	6	4
4------------	3,910	550	305	7	4
Tributary 1					
1------------	10,200	1,310	403	8	9
2------------	8,560	1,330	528	6	6
3------------	6,140	884	352	7	5
4------------	2,740	452	284	6	3
5------------	2,120	344	224	6	4
Tributary 1.1					
2------------	4,150	646	474	6	6
3------------	3,360	589	439	6	4
4------------	2,740	415	352	7	3
5------------	1,920	348	425	6	3

Table 1.--*Floodflow characteristics for the 100-year flood*--Continued

Flooding source and cross section	Discharge	Area	Width	Mean velocity	Maximum depth
<u>Tributary 1.1.4</u>					
1------------	1,260	([3])	([3])	([3])	([3])
<u>Tributary 1.3</u>					
1------------	5,700	1,340	1,360	4	3
2------------	2,950	([3])	([3])	([3])	([3])
3------------	1,730	([3])	([3])	([3])	([3])
<u>Tributary 1.3.1</u>					
1------------	2,640	([3])	([3])	([3])	([3])
2------------	2,330	385	335	6	2
<u>Tributary 1.3.2</u>					
1------------	2,630	579	495	5	3
2------------	1,870	384	386	5	2
3------------	1,420	184	169	8	3
<u>Tributary 1.3.2.1</u>					
1[4]-----------	[2]2,280	363	268	6	3
<u>Tributary 1.3.3</u>					
1------------	1,650	398	588	4	1
<u>Tributary 1.5</u>					
1------------	4,060	([3])	([3])	([3])	([3])
2------------	3,300	681	600	5	4
3------------	2,200	376	219	6	3
4------------	1,740	([3])	([3])	([3])	([3])
<u>Tributary 1.5.6</u>					
1------------	1,220	298	362	4	1
<u>Tributary 1.6</u>					
1------------	2,380	678	913	4	3
2------------	2,040	328	199	6	3
<u>Tributary 2</u>					
1------------	1,540	168	70	9	4
2------------	710	144	173	5	3
3------------	[5]280	51	125	5	1

[1]Same as cross-section 1 on tributary 1.3.2.1.

[2]Combined flows of tributaries 1.1.2 and 1.3.2.1.

[3]Floodflow characteristic not determined because discharge was not confined on one channel bank.

[4]Same as cross-section 4 on tributary 1.1.2.

[5]Estimated at approximately 40 percent of discharge of preceding cross-section 2.

The 500-year flood discharge at each selected stream site was determined from the extrapolation of the magnitude-frequency curve defined by the plots of the computed 10-, 25-, 50-, and 100-year discharges on a log-probability graph. The estimated discharges for the 500-year flood in the study area are listed in table 2.

Maximum Potential Flood

The history of flooding on Topopah Wash is not known, but data from maximum floods that have been observed on other streams having similar flood potential provide the best estimate of maximum potential flooding in the study area. Crippen and Bue (1977) compiled and analyzed selected maximum observed flood peaks [illegible]

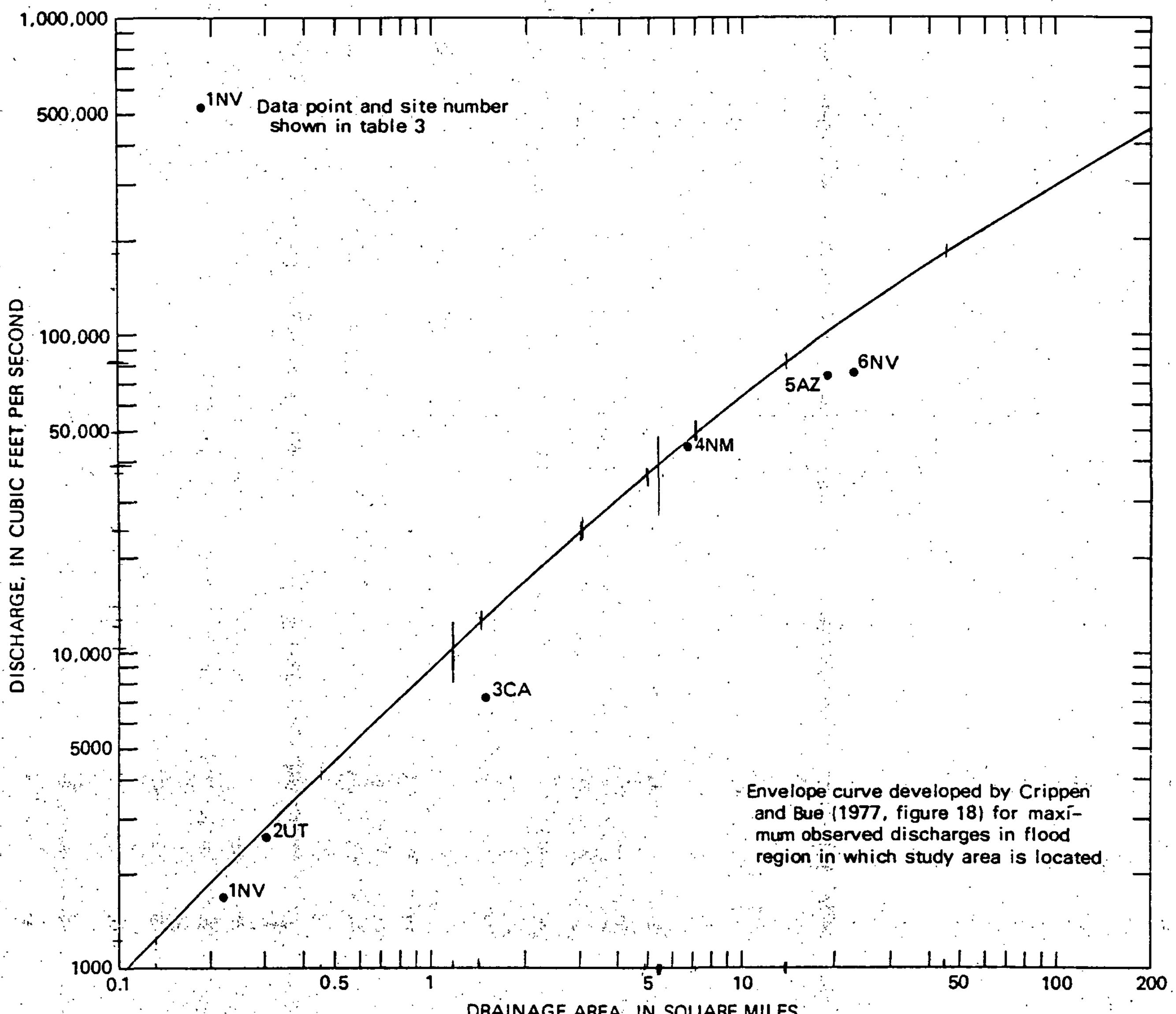


Figure 6.--Maximum potential discharge versus drainage area.

Table 2.--*Floodflow characteristics for the 500-year flood*

Flooding source and cross section: Stream-channel name and cross-section number shown on plate 1.
Discharge: 500-year discharge, in cubic feet per second.
Area: Cross-sectional area below the water surface, in square feet.
Width: Distance along cross section at the water surface and between defined end points, in feet. The end points may be located on channel banks or at imaginary divisions of out-of-bank flow between adjacent channels. The imaginary division of flow was determined, in general, by prorating the flood plain between adjacent channels in proportion to the magnitude of the 500-year discharges in the two channels.
Mean velocity: Discharge divided by area, in feet per second.
Maximum depth: Vertical distance from water surface to lowest point in cross section, in feet.

Flooding source and cross section	Discharge	Area	Width	Mean velocity	Maximum depth
Topopah Wash					
1------------	32,000	2,470	498	13	10
2------------	16,000	1,470	406	11	6
3------------	13,700	1,580	612	9	5
4------------	11,800	1,200	487	10	6
Tributary 1					
1------------	31,000	2,680	430	12	12
2------------	26,000	2,600	566	10	9
3------------	20,000	2,270	637	9	8
4------------	9,400	1,000	323	9	5
5------------	7,600	890	312	9	6

Table 2.--*Floodflow characteristics for the 500-year flood*--Continued

Flooding source and cross section	Discharge	Area	Width	Mean velocity	Maximum depth
Tributary 1.1.3.1					
1------------	3,750	617	770	6	[1]1
Tributary 1.1.4					
1------------	4,650	784	1,005	6	[1]1
Tributary 1.3					
1------------	18,500	3,170	1,858	6	[1]2
2------------	10,200	2,170	2,186	5	[1]1
3------------	6,200	1,050	1,226	6	[1]1
Tributary 1.3.1					
1------------	9,400	2,090	1,818	4	[1]1
2------------	8,050	866	352	9	4
Tributary 1.3.2					
1------------	9,400	1,690	989	6	[1]2
2------------	6,650	1,490	2,795	4	[1]1
3------------	5,200	738	594	7	[1]1
Tributary 1.3.2.1					
1[5]-----------	[4]8,550	850	336	10	5
Tributary 1.3.3					
1-----------	6,100	923	722	7	2
Tributary 1.5					
1------------	14,400	1,800	608	8	[1]3
2------------	11,800	1,810	861	7	5
3------------	8,200	1,420	904	6	4
4------------	6,550	952	609	7	[1]2
Tributary 1.5.6					
1------------	4,600	1,030	1,253	4	2
Tributary 1.6					
1------------	8,250	1,690	1,419	5	3
2------------	7,200	712	232	10	5
Tributary 2					
1------------	5,900	462	138	13	7
2------------	3,000	928	2,314	3	([6])
3------------	[7]1,200	193	155	6	2

[1]Mean depth in cross section, area divided by width.

[2]Floodflow characteristic not determined because definition of cross-section end points was too indefinite.

[3]Same as cross-section 1 on tributary 1.3.2.1.

[4]Combined flows of tributaries 1.1.2 and 1.3.2.1.

[5]Same as cross-section 4 on tributary 1.1.2.

[6]Mean depth about 0.4 foot.

[7]Estimated at 40 percent of discharge at preceding cross-section 2.

Table 3.--*Maximum observed discharges at six selected sites in Arizona, California, Nevada, New Mexico, and Utah*

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1NV	Lahonton Reservoir tributary no. 3 near Silver Springs, Nev------------------------	0.22	7-20-71	1,680	7,640
2UT	Little Pinto Creek tributary near Newcastle, Utah-------	.30	8-11-64	2,630	8,770
3CA	Arch Creek near Earp, Calif--	1.52	8-19-71	7,160	4,710
4NM	El Rancho Arroyo near Pojoaque, N. Mex-----------	6.7	8-22-52	44,000	6,570
5AZ	Bronco Creek near Wikieup, Ariz----------------------	19.0	8-18-71	73,500	3,870
6NV	Eldorado Canyon, Nev---------	22.8	9-14-74	76,000	3,330

Most channels in the study area are not portrayed in sufficient detail on the available topographic maps (pl. 1) to make reliable estimates of discharge capacities or to delineate flood-plain boundaries. Consequently, 47 typical channel cross sections were measured at the locations shown on plate 1. When the discharge capacities of the cross sections were exceeded by the three floods, the cross sections were extended on the basis of the topography on plate 1. At cross sections where out-of-bank flow apparently would occur, the cross sections were ended at imaginary divisions of flow on the flood plains. The imaginary division of flow was determined by prorating the distance across the flood plain between adjacent channels by the magnitudes of the floodflows in the two channels. For example, a channel having two-thirds of the sum of the floodflows in adjacent channels would be given two-thirds of the intervening flood plain in its cross section.

Channel-roughness factors (Manning's n) used in the hydraulic computations were chosen by engineering judgment and based on observations of the channels and flood-plain areas. Roughness values for the main channels range from 0.030 to 0.050 with flood-plain roughness values ranging from 0.038 to 0.055 for all floods.

Flood depths for the three floods were computed at each cross section using the following equation by Manning (Dalrymple and Benson, 1967), which provides a relationship between discharge and each selected depth in a cross section:

$$Q= \frac{1.486}{n} AR^{2/3}S^{1/2}, \tag{1}$$

where Q=discharge, in cubic feet per second, for a given flood depth;
- n=Manning roughness coefficient, based on field observation of channel and flood plains;
- A=area of cross section, in square feet, for a given flood depth;
- R=hydraulic radius, in feet, which is the ratio of the area to the wetted perimeter of the cross section; and
- S=friction slope, approximated by streambed slope determined from topographic contours shown on plate 1.

At each cross section a depth-discharge relation was developed by computing discharges for several depths through the range in discharge of the three floods. From this relation, the depth of floodflow for each flood was determined at each cross section and plotted on streambed profiles for the development of profiles for the three floods. Typical cross sections showing the water surfaces for the three floods are illustrated in figure 7.

Characteristics of floodflow (discharge, area, width, mean velocity, and maximum depth) that were determined at channel cross sections for the 100-year flood are listed in table 1, for the 500-year flood in table 2, and for the maximum potential flood in table 4. The flood-prone areas shown on plate 1 were outlined on the basis of information determined at the cross sections, and from flood profiles, and from streamlines and topographic contours shown on plate 1.

Table 4.--*Floodflow characteristics for the maximum potential flood*

Flooding source and cross section: Stream-channel name and cross-section number shown on plate 1.
Discharge: Maximum potential flood discharge, in cubic feet per second.
Area: Cross-sectional area below the water surface, in square feet.
Width: Distance along cross section at the water surface and between defined end points, in feet. The end points may be located on channel banks or at imaginary divisions of out-of-bank flow between adjacent channels. The imaginary division of flow was determined, in general, by prorating the flood plain between adjacent channels in proportion to the magnitude of the 500-year discharges in the two channels.
Mean velocity: Discharge divided by area, in feet per second.
Maximum depth: Vertical distance from water surface to lowest point in cross section, in feet.

Flooding source and cross section	Discharge	Area	Width	Mean velocity	Maximum depth
Topopah Wash					
1-----------	310,000	12,700	1,179	24	23
2-----------	160,000	6,810	908	23	16
3-----------	160,000	7,210	806	22	13
4-----------	130,000	4,950	540	26	13
Tributary 1					
1------------	235,000	([1])	([1])	([1])	([1])
2------------	192,000	9,790	877	20	19
3------------	123,000	([1])	([1])	([1])	([1])
4------------	43,700	3,410	876	13	9
5------------	33,800	3,030	732	11	10
Tributary 1.1					
1------------	92,500	([1])	([1])	([1])	([1])
2------------	92,500	9,160	2,705	10	[2]3
3------------	73,200	6,930	1,780	11	[2]4
4------------	53,800	4,010	884	13	[2]4
5------------	38,100	4,970	3,885	8	[2]1
Tributary 1.1.1					
1------------	22,000	3,100	1,462	7	4
2------------	9,100	1,930	2,425	5	[2]1
3------------	4,100	590	343	7	4
4------------	4,100	([1])	([1])	([1])	([1])
Tributary 1.1.2					
1------------	29,000	3,300	1,438	9	[2]2
2------------	29,000	2,930	1,185	10	[2]2
3------------	14,000	2,290	1,680	6	[2]1
4[3]-----------	[4]27,000	1,800	440	15	7
Tributary 1.1.3					
1------------	33,000	3,260	1,129	10	[2]3
2------------	33,000	([1])	([1])	([1])	([1])
3------------	18,000	1,480	556	12	7

Table 4.--*Floodflow characteristics for the maximum potential flood*--Continued

Flooding source and cross section	Discharge	Area	Width	Mean velocity	Maximum depth
Tributary 1.1.3.1					
1------------	13,000	1,460	770	9	[2]2
Tributary 1.1.4					
1------------	15,000	2,160	1,525	7	[2]1
Tributary 1.3					
1------------	120,000	10,300	2,186	12	[2]5
2------------	54,000	5,840	2,385	9	[2]2
3------------	29,000	([1])	([1])	([1])	([1])
Tributary 1.3.1					
1------------	47,000	6,060	2,375	8	[2]2
2------------	40,000	2,310	386	17	8
Tributary 1.3.2					
1------------	43,000	4,130	1,020	10	[2]4
2------------	29,000	4,780	3,340	6	[2]1
3------------	33,000	4,600	3,565	7	[2]1
Tributary 1.3.2.1					
1[5]-----------	[4]27,000	1,800	440	15	7
Tributary 1.3.3					
1------------	24,000	3,010	1,790	8	[2]2
Tributary 1.5					
1------------	64,000	5,320	1,110	12	[2]5
2------------	50,000	5,020	1,374	10	[2]4
3------------	27,000	3,900	1,663	7	6
4------------	18,000	2,020	708	9	[2]3
Tributary 1.5.6					
1------------	12,000	2,130	1,680	6	2
Tributary 1.6					
1------------	39,000	4,720	2,000	8	5
2------------	32,000	2,000	401	16	9
Tributary 2					
1------------	14,000	1,870	1,570	7	[2]1
2------------	4,300	1,160	2,845	4	([6])
3------------	[7]1,720	240	163	7	2

[1]Floodflow characteristic not determined because definition of cross-section end points was too indefinite.

[2]Mean depth in cross section, area divided by width.

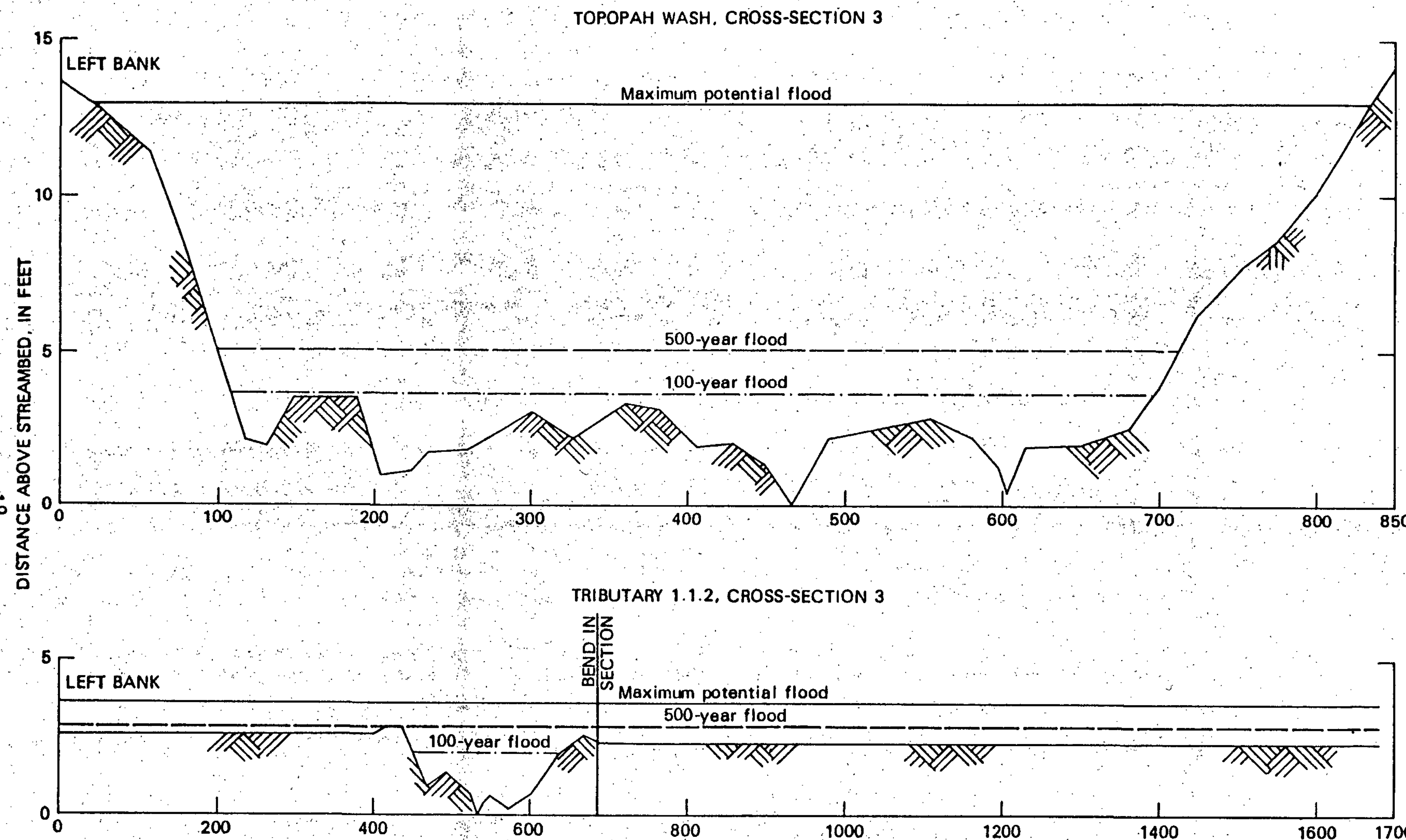
[3]Same as cross-section 1 on tributary 1.3.2.1.

[4]Combined flows of tributaries 1.1.2 and 1.3.2.1.

[5]Same as cross-section 4 on tributary 1.1.2.

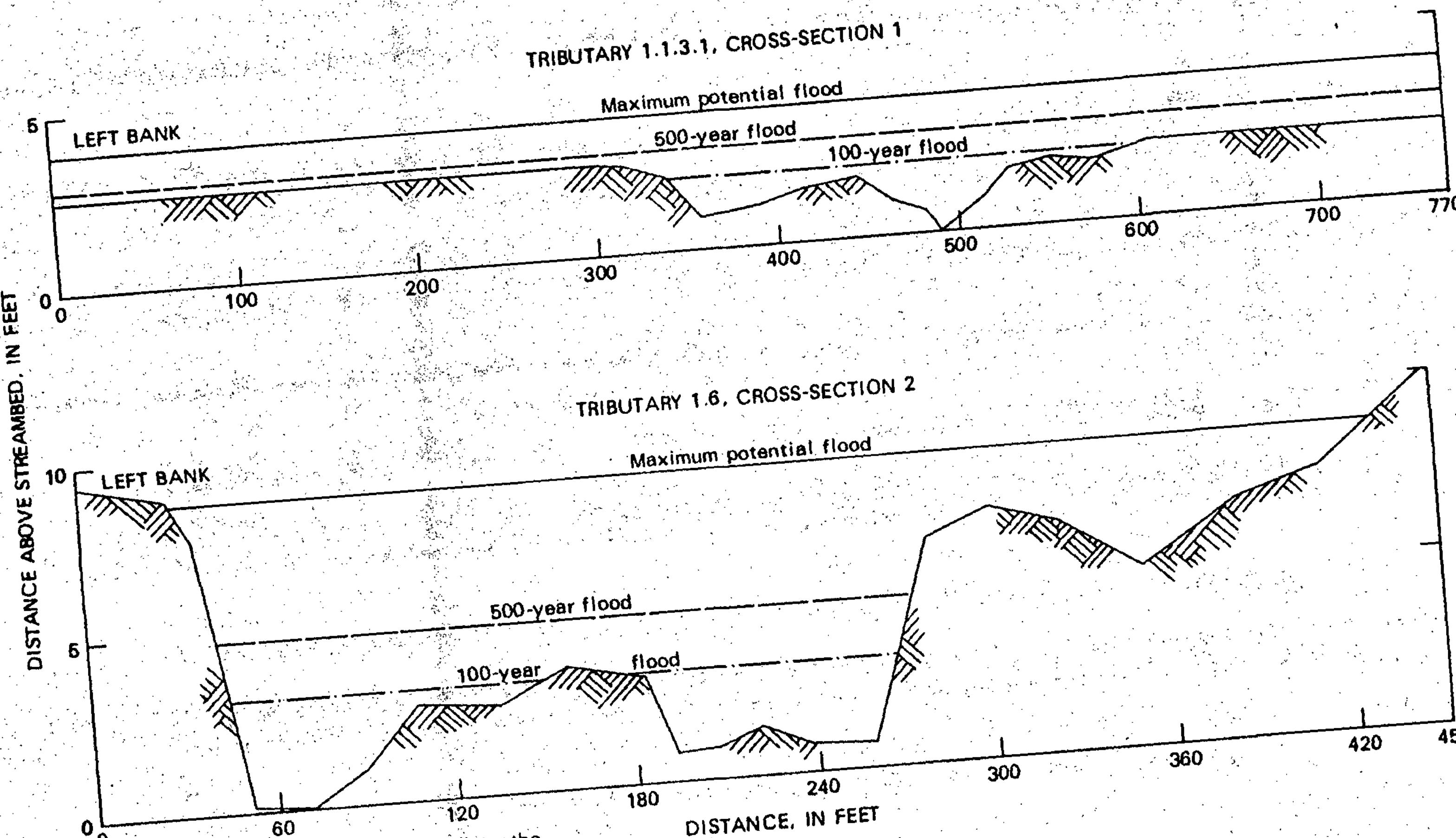
[6]Mean depth about 0.4 foot.

[7]Estimated at 40 percent of discharge at preceding cross-section 2.



Note: Flood elevations are shown to tenths of feet, whereas maximum and mean depths shown in tables 1, 2, and 4 are rounded to the nearest foot

Figure 7.--Typical cross sections showing water surfaces for the 100- and 500-year floods, and the maximum potential flood.



NOTE: Flood elevations are shown to tenths of feet, whereas maximum and mean depths shown in tables 1, 2, and 4 are rounded to the nearest foot

Figure 7.-- Typical cross sections showing water surfaces for the 100- and 500-year floods, and the maximum potential flood.--Continued.

FLOODFLOW CHARACTERISTICS

Approximate areas that would be inundated by the 100- and 500-year floods, and by the maximum potential flood are shown on plate 1. The flood-prone areas for the 100-year flood, as depicted on plate 1, would closely parallel most stream channels. Out-of-bank flooding between adjacent channels is shown between tributaries 1.1.3 and 1.1.4, 1.1.2 and 1.3.2.1, and 1.3 and 1.3.1. Out-of-bank flooding would occur at depths of less than 2 feet with mean velocities as much as 7 feet per second on the steeper slopes. Maximum flood depths in the main channels would average about 3 feet and range in depth from 1 foot in the upstream reaches of several tributaries to 9 feet at the mouth (cross-section 1) of tributary 1. Mean velocities of floodflows in the channels would range from 3 to 9 feet per second with the greatest velocity occurring at cross-section 1 on Topopah Wash and at cross-section 1 on tributary 2.

The 500-year flood would exceed the discharge capacities of all channels except for the channel of Topopah Wash and the channels in upstream reaches of a few tributaries. Out-of-bank flows between adjacent channels would occur at depths as much as 3 feet and mean velocities more than 7 feet per second. Maximum flood depths in the main channels would range from 1 to 12 feet with the greatest depth occurring at the mouth of tributary 1. The mean velocities would range from 3 to 13 feet per second with the greatest velocity occurring at cross-section 1 on Topopah Wash and at cross-section 1 on tributary 2.

The maximum potential flood would inundate most of the study area; exceptions would be areas between Topopah Wash and tributaries 1.1.1 and 2, and between upstream channel reaches of some of the other tributaries. Topopah Wash would overtop its banks between the 3,380- and 3,600-foot topographic contours. Out-of-bank flows between adjacent channels would occur at depths as much as 5 feet and mean velocities as much as 13 feet per second. Maximum flood depths in the main channels would range from 2 feet in the upstream reaches of tributary channels to 23 feet at cross-section 1 on Topopah Wash downstream from tributary 1. The mean velocities would range from 4 to 26 feet per second with the greatest velocity occurring at cross-section 4 on Topopah Wash.

SUMMARY

Floods that occur in Jackass Flats are associated with moist-air flows from the Pacific Ocean and the Gulf of California. Precipitation from widespread winter storms only rarely is sufficiently intense to cause flooding; however, the more likely cause of flooding is the precipitation from the localized intense summer convective thunderstorms.

Estimates of 100-year, 500-year, and maximum potential floods were determined at selected stream sites. Flood-frequency relations based on 71 gaged basins in Nevada were used for the 100- and 500-year floods, and an envelope curve, defined by six maximum observed discharges--in terms of discharge per unit of area--that occurred in the hydrologic region in which the study area is located, was used for the maximum potential flood. Discharges determined for the three floods are listed in tables 1, 2, and 4.

Hydraulic characteristics of stream channels and flood plains were based on natural-flow conditions, 47 channel cross sections and Manning's roughness coefficients obtained in the field, and estimated discharges for the three floods. Flood depths at each cross section for the three floods were computed using Manning's equation relating discharge to channel-hydraulic properties.

The 100-year flood-prone areas would closely parallel most main-stream channels with very few occurrences of out-of-bank flooding between adjacent channels. Out-of-bank flooding would occur at depths of less than 2 feet with mean velocities as much as 7 feet per second on the steeper slopes. Channel flood depths would range from 1 to 9 feet and mean velocities would range from 3 to 9 feet per second.

The 500-year flood would exceed the discharge capacities of all channels except for Topopah Wash and the channels in upstream reaches of a few tributaries. Out-of-bank flows between adjacent channels would occur at depths as much as 3 feet with mean velocities more than 7 feet per second. Channel flood depths would range from 1 to 12 feet and mean velocities would range from 3 to 13 feet per second.

The maximum potential flood would inundate most of the study area. Excluded areas would be those located immediately east of the upstream reach of Topopah Wash and between upstream channel reaches of some tributaries. Out-of-bank flows between adjacent channels would occur at depths as much as 5 feet with mean velocities as much as 13 feet per second. Channel flood depths would range from 2 to 23 feet and mean velocities would range from 4 to 26 feet per second.

Severe erosion of channels and flood plains would occur in parts of the study area during the 100-year flood, and would be more widespread during the 500-year flood and the maximum potential flood. Channels eroded from their present condition would alter the floodflow characteristics shown in this report.

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